



Castrol ON Direct Liquid Cooling PG 25: Operating guide



Material compatibility, safety, installation, and maintenance

This guide introduces Castrol ON Direct Liquid Cooling PG 25, covering its use cases, material compatibility, safety and storage guidance, system installation, and fluid maintenance. It also outlines key handling procedures and monitoring protocols aligned with OCP guidelines.

1. Introduction

Air cooling has been the traditional method for dissipating heat in IT applications, but with the advent of AI and other disruptive data heavy technologies, we are now at an inflection point where rack power densities and silicon designs require a more efficient way of cooling - liquid cooling. Direct liquid cooling (or direct to chip cooling), utilizes the beneficial heat transfer properties of glycol- and water-based fluids. Castrol ON Direct Liquid Cooling PG 25 has been developed to address the challenge presented by the higher TDP (Thermal Design Power) and temperatures of current and emerging CPUs and GPUs in cold plate applications. Cold plates sit on top of the heat-generating components and transfer the heat to the fluid, which transfers the heat subsequently to a heat exchanger placed in a Coolant Distribution Unit (CDU) positioned within the rack, the row or at the periphery of the room.

The proprietary formulation provides for extended life performance with the inhibitor package depleting very little over time when maintained in accordance with the recommended guidelines.

Castrol ON Direct Liquid Cooling PG 25 is a propylene glycol-based heat transfer fluid that supports the deployment of direct to chip cooling in data center and edge environments. It's specifically formulated to provide durability and longevity, whilst at the same time delivering excellent heat transfer and outstanding corrosion protection. The product is supplied in a diluted state and requires no further preparation prior to installation and system startup, saving time and cost when attending site.

Castrol ON Direct Liquid Cooling PG 25 is developed for:

- Optimal heat transfer properties
- Stability – no deposits, no scaling
- Efficient corrosion inhibition
- High water quality
- Durability and longevity

For the typical characteristics of Castrol ON Direct Liquid Cooling PG 25, please see the corresponding PDS.

2. Wetted Material Compatibility

Wetted Materials are those coming into contact with the heat transfer fluid such as, but not limited to, pump seals, heat exchangers and quick connect seals. The heat transfer fluid specification is tied closely to the wetted material list, and compatibility should be evaluated against the complete range of temperatures the materials will be subjected to. The compatibility of Castrol ON Direct Liquid Cooling PG 25 has been tested with a broad variety of different metals, alloys, rubbers, plastics and elastomers. The compatibility with frequently used materials is stated within this chapter. For further information on the compatibility with other materials, contact Castrol. It is highly recommended to ensure the compatibility of the used heat transfer fluid with all wetted materials prior to application. It should also be noted that operation of the system above the recommended maximum temperature of 65 °C might influence the stated compatibility. For further information, contact Castrol.

Metals and Metal Alloys

Experimental data on corrosion protection is available for a certain range of metals and metal alloys. Compatibility based on experimental data, experience and expected compatibility from OCP guidelines for frequently used materials under usual operating conditions are shown in Table 1.

Table 1:

Compatibility of Castrol ON Direct Liquid Cooling PG 25 with frequently used metal and metal alloys

Material	Material details as per OCP Guidelines
Copper	CDA110, CDA1020, CDA1220, CDA1100
Brass	
Stainless Steel	304L, 316L or higher grades
Nickel, high nickel alloys	Avoid Hastelloy B and other alloys designed for reducing environments
Chromium	Plated corrosion resistant materials
Titanium	Grade 2 (UNS R50400)
B-Ni-6	88.9% Ni + 11% P
BCuP-1	95% Cu + 5% P
BCuP-2	93% Cu + 7% P
BCuP-3	Cu 89%, Ag 5%, P 6%, others 0.15%
BCuP-4	Cu 87%, Ag 6%, P 7%
BCuP-5	Cu 80%, Ag 15%, P 5%
TF-H600F	Cu 74.9%, Sn 15.6%, P 5.3%, Ni 4.2%
Solder	
Cast Iron	
Aluminum	

For further information on the compatibility of Castrol ON Direct Liquid Cooling PG 25 with other metals and metal alloys, contact Castrol.

Elastomers, Plastics, and Sealants

Experimental data on compatibility is available for a broad range of elastomers, plastics, and sealants. Compatibility based on experimental data, experience and expected compatibility due to OCP guidelines for frequently used materials under usual operating conditions are shown in Table 2. For further information on the compatibility of Castrol ON Direct Liquid Cooling PG 25 with other elastomers, plastics, and sealants, contact Castrol.

Table 2:
Compatibility of Castrol ON Direct Liquid Cooling PG 25 with frequently used elastomers, plastics, and sealants

Material	Material details from OCP Guidelines
EPDM	Ethylene propylene diene monomer
Viton	A, GF, ETP
FEP	Fluorinated ethylene propylene polymer
PTFE	Polytetrafluoroethylene polymer
PP	Polypropylene
HDPE	High density polyethylene
PEEK	Poly ether ether ketone
Loctite 567	Thread sealant

3. Safety

Castrol recommends that users always consult the latest Safety Data Sheets prior to implementing the fluids in your facility. Please also consider any local laws and regulations prior to use, noting that these may change at periodic intervals. It is the responsibility of the user to ensure the suitability of the fluid for the individual application and compliance with the relevant jurisdiction.

It is important that the user is prepared to handle system leaks on a small and large scale, ensuring absorbent materials and fluid containers are on hand and applicable for any incidents.

For safe handling, refer to Section 4 (First aid measures) and Section 8 (Personal protection) of SDS (Safety Data Sheet).

4. Storage Conditions

Storage: The container will arrive sealed. Do not break the seal prior to use. Storage recommendations of Castrol ON Direct Liquid Cooling PG 25:

- Avoid sunlight
- Storage temperature: < 30 °C
- Shelf-life: 36 months. After shelf-life expires, analytical testing is recommended prior to use
- Expected lifespan: 5-12 years depending on the design and the maintenance of the system

5. Site preparation and installation of Castrol ON Direct Liquid Cooling PG 25

For system design considerations, following the OCP guideline (Guideline for using propylene glycol-based heat transfer fluids) is recommended. It is recommended that system filling and drainage points are allowed to accommodate the addition of any boosters on an ad-hoc basis without interrupting the operation of the TCS (Technology Cooling System). These points should meet the specifications outlined in the wetted materials list and ensure there are no sections of pipework where fluid can stagnate.

It is important that dynamic flushing of the pipework system is carried out to remove any debris, dirt, or particles from inside of the system. This should be done in accordance with the cooling system provider's recommendations and warranty requirements. If a chemical clean is conducted prior to system fill, it is important that all chemical cleaning fluid should be drained, and the pipework is flushed with water until all residue is removed.

Mechanical engineers should be consulted to ensure the system is viewed at a holistic level that prevents excessive pressure drop or flow velocity due to incorrect pipe sizing. The TCS approach temperature will influence the viscosity of the Castrol ON Direct Liquid Cooling PG 25 which will in turn impact the system pressure drop. Air bleed points should be designed for the high points of the system to allow venting during the system fill and prevent potential problems leading to adverse thermal performance, potential system downtime, possible pump cavitation and / or pipework corrosion.

Filling a New System

The following steps are basic recommendations on filling a new system with Castrol ON Direct Liquid Cooling PG 25. For detailed working instructions, the design of the system needs to be evaluated.

Table 3:

Instructions on how to fill a new system with Castrol ON Direct Liquid Cooling PG 25

Conditioning		
1	Measure the pH of the fluid	<p>For fresh fluid: If out of sales specification, contact fluid supplier. Do not use.</p> <p>For used fluid: If out of specification, do not use.</p>
2	Fill the system with Castrol ON Direct Liquid Cooling PG 25 and flush for 30 minutes at 60 ± 5 °C	
3	Take a sample of the fluid and measure the pH	If visual appearance or pH differs by more than 0.5, repeat step 2.
4	Perform a pressure test	
5	Drain	
Filling		
1	Make sure to use sealed, fresh fluid	The use of stored leftovers needs to be checked prior to use.
2	Take a retention sample of the fluid	Document batch, date and mark as retention sample Day 0. Keep the sample as long as the fluid is in the system.
3	Warm up the product to 35 ± 5 °C	
4	Fill the system with Castrol ON Direct Liquid Cooling PG 25	
5	Purge the air of the system	
6	Do on-site testing or check the data for automated testing for the following parameters: <ul style="list-style-type: none"> • Appearance • pH • Glycol concentration 	Check against specifications stated in section on-site testing. If necessary, top up with glycol concentrate and repeat step 5 four hours later.
7	Take a retention sample of the fluid	Document batch, date and mark as retention sample Day 1. Keep the sample as long as the fluid is in the system.

6. Fluid maintenance and inspection

Upon completion of system flushing and filling with Castrol ON Direct Liquid Cooling PG 25, a fluid sample should be taken and stored so that a baseline of the system is recorded. This is referred to as retention sample Day 0 and Day 1 in section 5.2.

The monitoring program involves routine monitoring performed on-site and annual analytics.

Routine Monitoring

In the absence of a dynamic monitoring system, routine monitoring of the heat transfer fluid should be done at least on a quarterly basis. The properties to be analyzed should be at least the following:

- Appearance
- pH
- Glycol concentration

The determined properties should be in range of the following specifications:

Table 4:
Specifications of Castrol ON Direct Liquid Cooling PG 25 in use for routine monitoring

Properties	Unit	Typical value
Propylene Glycol	Vol%	24.5 - 29
Color	-	Green
Appearance	-	Clear liquid, free from suspended matter
pH	-	8.0 – 9.5

If the specifications are not met, it is recommended to take an additional sample to confirm the out of specification results. If the result is confirmed, it is recommended to contact Castrol to either initiate an analysis at a laboratory or replenish the heat transfer fluid.

Annual Analytics

In addition to the routine monitoring of the heat transfer fluid, an analysis of the condition of the fluid and the system should be performed in a laboratory. The analysis should at least consist of following tests:

Table 5:

Properties to test
Castrol ON Direct Liquid
Cooling PG 25 in use on
an annual basis

Properties	Typical test
Appearance	Visual
pH	ASTM D1287
Glycol concentration	ASTM D3321
Freeze point	ASTM D3321
Anions	ASTM D5827
Reserve Alkalinity	ASTM D1121
Elements	ASTM D6130
OAT inhibitors	HPLC
Optional: Electrical conductivity	
Optional: Total dissolved solids	

Due to the complexity of the interpretation, the results should be shared with Castrol for recommendations on actions in case of issues with the system.



For any additional
information or concerns,
please contact your
Castrol representative
or reach out via email at
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